



Soil carbon sequestration to mitigate climate change and advance food security

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Abstract:

World soils have been a source of atmospheric carbon dioxide since the dawn of settled agriculture, which began about 10 millennia ago. Most agricultural soils have lost 30% to 75% of their antecedent soil organic carbon (SOC) pool or 30 to 40 t C ha⁻¹. The magnitude of loss is often more in soils prone to accelerated erosion and other degradative processes. On a global scale, CO₂-C emissions since 1850 are estimated at 270 +/- 30 giga ton (billion ton or Gt) from fossil fuel combustion compared with 78 +/- 12 Gt from soils. Consequently, the SOC pool in agricultural soils is much lower than their potential capacity. Furthermore, depletion of the SOC pool also leads to degradation in soil quality and declining agronomic/biomass productivity. Therefore, conversion to restorative land uses (e.g., afforestation, improved pastures) and adoption of recommended management practices (RMP) can enhance SOC and improve soil quality. Important RMP for enhancing SOC include conservation tillage, mulch farming, cover crops, integrated nutrient management including use of manure and compost, and agroforestry. Restoration of degraded/desertified soils and ecosystems is an important strategy. The rate of SOC sequestration, ranging from 100 to 1000 kg ha⁻¹ year⁻¹, depends on climate, soil type, and site-specific management. Total potential of SOC sequestration in the United States of 144 to 432 Mt year⁻¹ (288 Mt year⁻¹) comprises 45 to 98 Mt in cropland, 13 to 70 Mt in grazing land, and 25 to 102 Mt in forestland. The global potential of SOC sequestration is estimated at 0.6 to 1.2 Gt C year⁻¹, comprising 0.4 to 0.8 Gt C year⁻¹ through adoption of RMP on cropland (1350 Mha), and 0.01 to 0.03 Gt C year⁻¹ on irrigated soils (275 Mha), and 0.01 to 0.3 Gt C year⁻¹ through improvements of rangelands and grasslands (3700 Mha). In addition, there is a large potential of C sequestration in biomass in forest plantations, short rotation woody perennials, and so on. The attendant improvement in soil quality with increase in SOC pool size has a strong positive impact on agronomic productivity and world food security. An increase in the SOC pool within the root zone by 1 t C ha⁻¹ year⁻¹ can enhance food production in developing countries by 30 to 50 Mt year⁻¹ including 24 to 40 Mt year⁻¹ of cereal and legumes, and 6 to 10 Mt year⁻¹ of roots and tubers. Despite the enormous challenge of SOC sequestration, especially in regions of warm and arid climates and predominantly resource-poor farmers, it is a truly a win-win strategy. While improving ecosystem services and ensuring sustainable use of soil resources, SOC sequestration also mitigates global warming by offsetting fossil fuel emissions and improving water quality by reducing nonpoint source pollution.

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Resource Description

Exposure : ☑

Climate Change and Human Health Literature Portal

weather or climate related pathway by which climate change affects health

Ecosystem Changes, Food/Water Security

Food/Water Security: Agricultural Productivity, Nutritional Quality

Geographic Feature: 

resource focuses on specific type of geography

None or Unspecified

Geographic Location: 

resource focuses on specific location

Global or Unspecified

Health Co-Benefit/Co-Harm (Adaption/Mitigation): 

specification of beneficial or harmful impacts to health resulting from efforts to reduce or cope with greenhouse gases

A focus of content

Health Impact: 

specification of health effect or disease related to climate change exposure

Malnutrition/Undernutrition

Intervention: 

strategy to prepare for or reduce the impact of climate change on health

A focus of content

Mitigation/Adaptation: 

mitigation or adaptation strategy is a focus of resource

Mitigation

Model/Methodology: 

type of model used or methodology development is a focus of resource

Exposure Change Prediction

Population of Concern: A focus of content

Population of Concern: 

populations at particular risk or vulnerability to climate change impacts

Low Socioeconomic Status, Workers

Resource Type: 

format or standard characteristic of resource

Research Article, Review

Timescale: ☒

time period studied

Long-Term (>50 years)

Vulnerability/Impact Assessment: ☒

resource focus on process of identifying, quantifying, and prioritizing vulnerabilities in a system

A focus of content